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(54) Infra red intruder detector

(57) A passive infra red intruder detector includes a sensor (9, 10) sensitive to changes in the pattern of infra red radiation within its detection range. The sensor operates in a wavelength range from 4 to 20 microns. A radio transmitter (23) is triggered upon the detection of a change in the pattern of infra red radiation and transmits a signal including a detector identification and an alarm indication. The detector includes a battery which provides a power supply for the sensor (9, 10) and the transmitter (23), and a solar cell powered battery charging circuit for recharging the battery.

In one example, two infra red sensors (9, 10) are mounted on a detector head with their principal axes at an angle of around 120° so that their fields of view overlap. Secondary infra red filters for the sensors are formed in the periphery of the detector head.

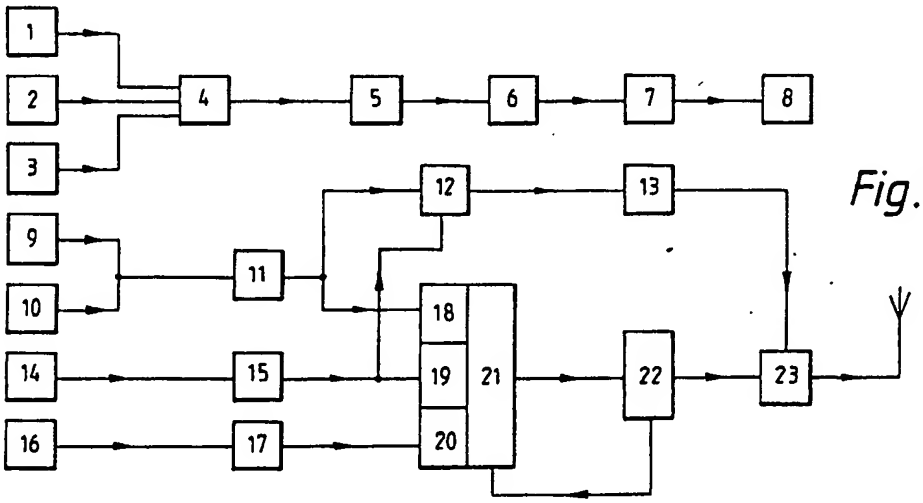
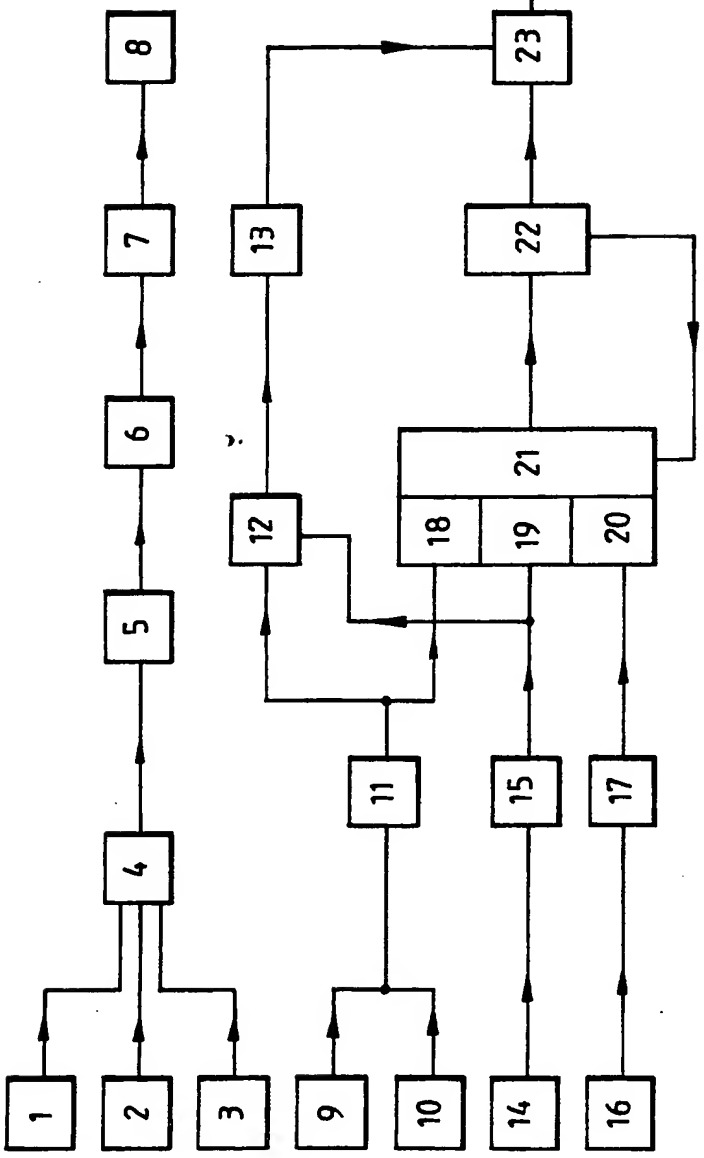


Fig.1

GB 2 235 316 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.


1
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22
23

Fig.1

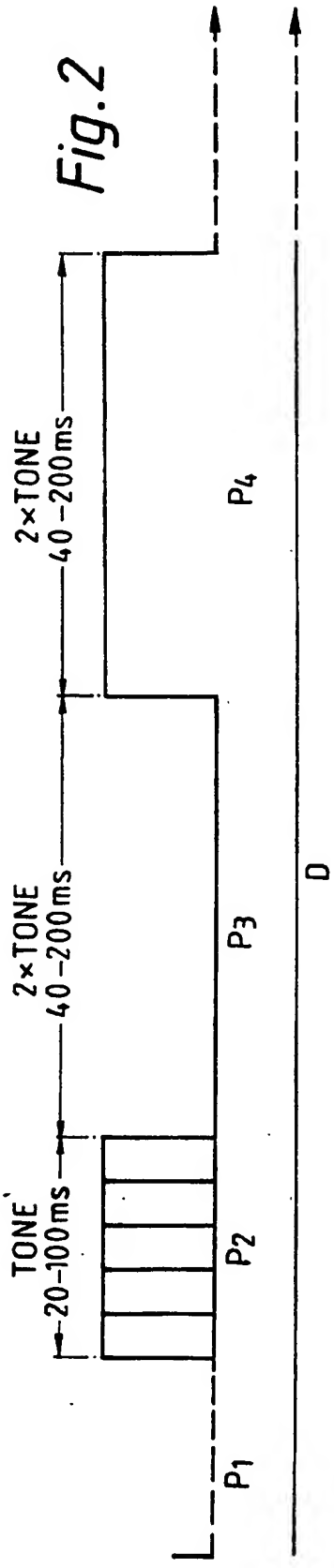

TONE'
20-100ms
2×TONE
40-200ms
2×TONE
40-200ms
P1
P2
P3
P4
D

Fig.2

Fig. 3

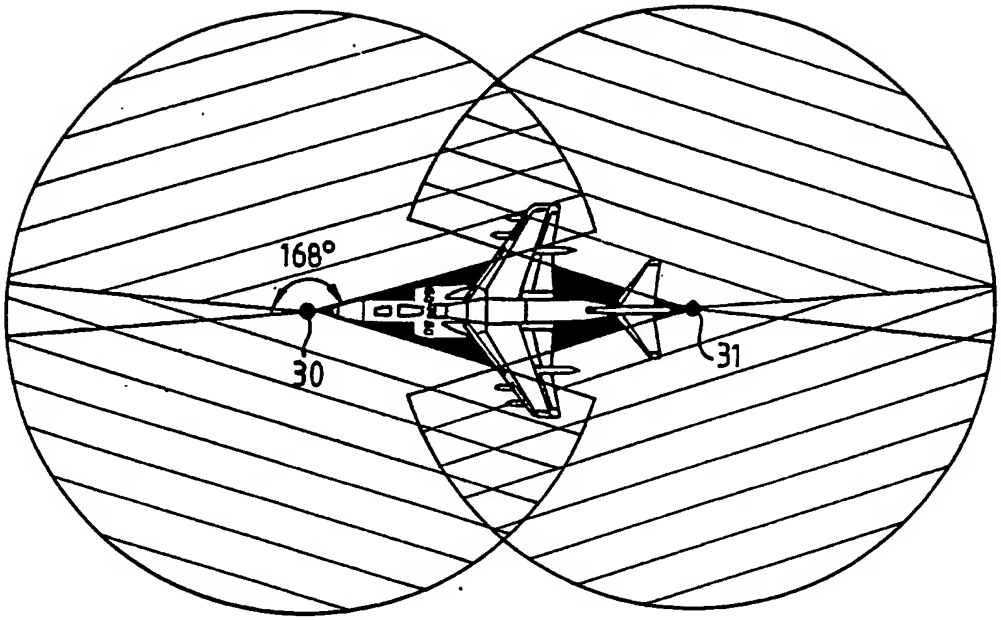
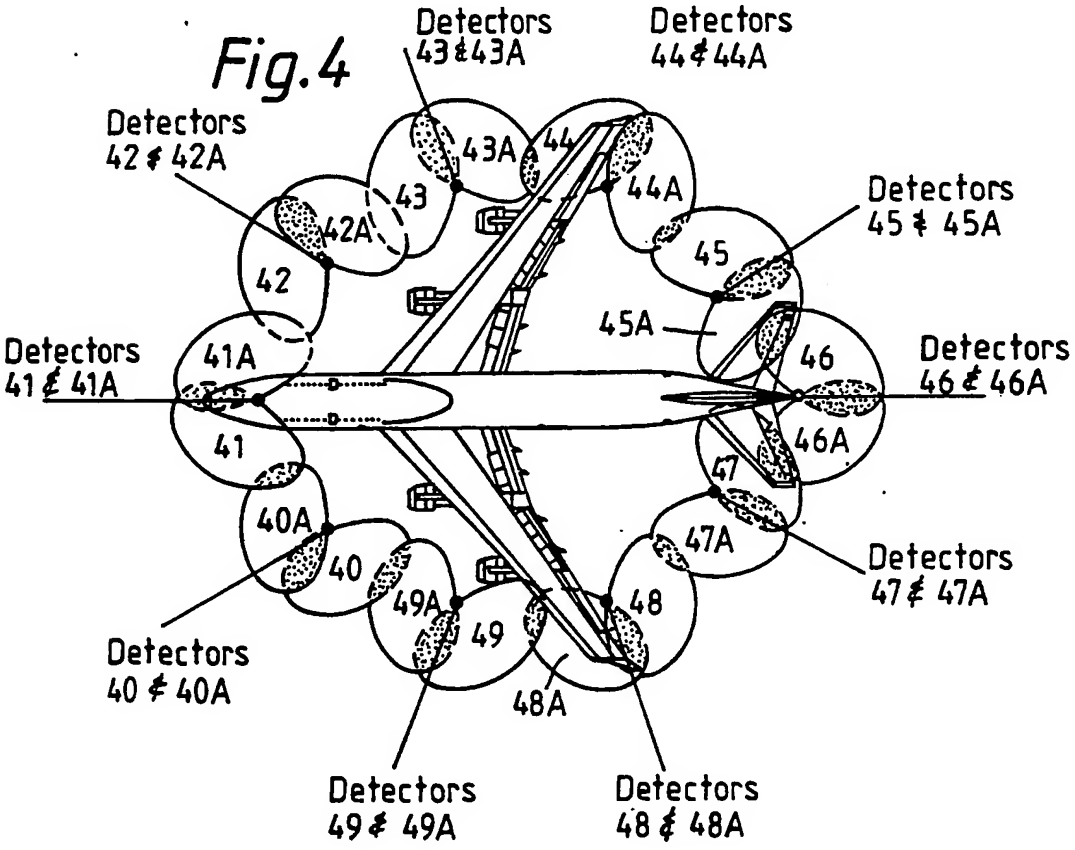

168°
30
31

Fig. 4


Detectors 43 & 43A
Detectors 44 & 44A
Detectors 42 & 42A
Detectors 45 & 45A
Detectors 41 & 41A
Detectors 46 & 46A
Detectors 47 & 47A
Detectors 40 & 40A
Detectors 49 & 49A
Detectors 48 & 48A
43A
44
44A
43
42A
42
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45A
41A
46
46A
41
47
40A
47A
40
49A
48
49
48A

Fig.5

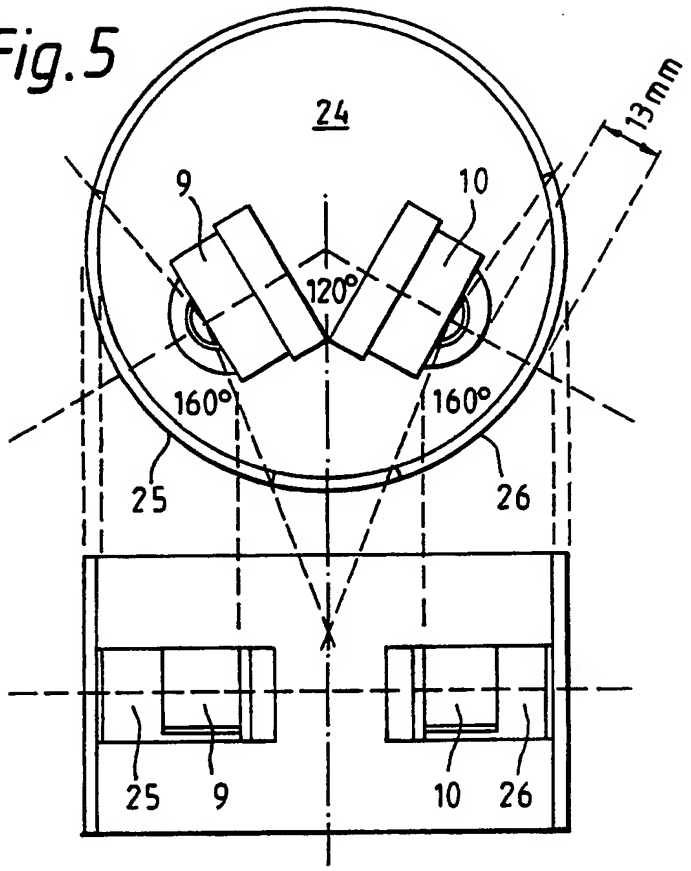
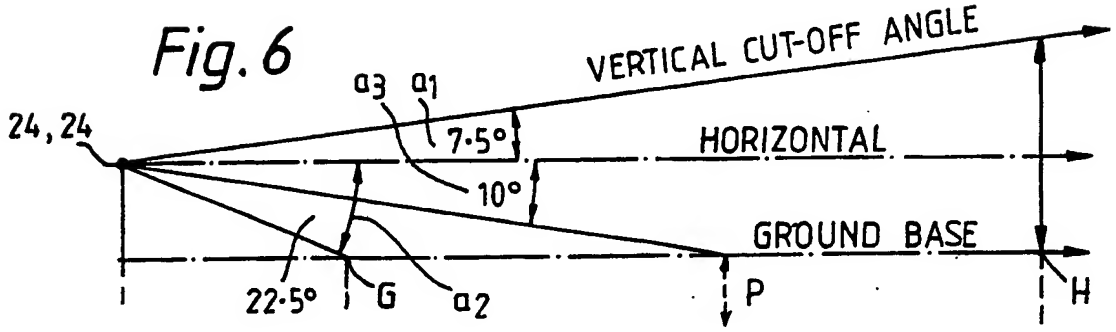

24
13mm
9
10
120°
160°
160°
25
26
25
9
10
26

Fig.6


VERTICAL CUT-OFF ANGLE
a3
a1
24, 24
7·5°
HORIZONTAL
10°
GROUND BASE
22·5°
G
a2
P
H

INFRA RED INTRUDER DETECTOR

There are numerous types of intruder detection devices and their associated alarm systems. They range from simple window catch switches and floor mounted pressure pads to highly sophisticated, air movement, ultrasonic, radio detectors and temperature change detectors. Each has its special attributes whether it be cost effectiveness, range, or adaptability which gives it an advantage over other systems.

The majority of secure areas i.e. those which are protected against intruders by detection and alarm systems are either within buildings or in enclosed areas. For the protection of such areas intruders are prevented from gaining access to the building or protected area, or once access has been gained into a complex of buildings, to prevent access to the more important areas. Such systems trigger alarms on the detection of some breach of a security zone or, for example, movement within it.

According to this invention a passive infra red intruder detector includes a sensor sensitive to changes in the pattern of infra red radiation within its detection range and in a wavelength range from 4 to 20 microns, a radio transmitter which transmits a signal including a detector identification and an alarm indication and which is triggered upon the detection of a change in the pattern of infra red radiation by the sensor, a battery providing a power supply for the sensor and transmitter, and a solar cell powered battery charging circuit for recharging the battery.

The passive infra red intruder detector in accordance with this invention is a self contained device that can be made completely portable so that it can be deployed on a temporary basis to enable an area to be protected without the requirement for a permanent

installation of hard wired detector devices. The device in accordance with the present invention is especially useful for protecting generally open areas from time to time when it is required to detect intrusion.

Thus, the present invention may be used remotely to detect movement and intrusion by an enemy into a battlefield area or, alternatively, it may be used in commerce to protect such things as construction sites, bonded stores, dockyards and aircraft in hangers or at dispersal points. The device may be camouflaged and in this case its risk of detection by an enemy force, or intruder, is very low. Radio transmissions are made only on detection of intrusion and accordingly it is difficult to locate such devices if they are well camouflaged.

Preferably more than one intruder detector are used together so that their individual detection zones form a continuous protective ring around an area to be protected. In such circumstances the identification signal transmitted by each detector in the event of it being triggered enables the location of the intruder around the periphery of a protected area to be identified.

The infra red sensor can detect the presence of a source of heat such as a human body or internal combustion engine or the presence of a body that is colder than that of its immediate surroundings. The sensor can detect entry into its detection zone of any such body and/or any subsequent movement of a body having a temperature difference from its surroundings within its detection zone. Preferably the infra red sensor includes a pyroelectric transducer with a built in preamplifier and is of the type known as a motion detection sensor such as that sold under the designation FRIM-188 available from B.I.R.D. (UK) Limited of E1 Foxhills Industrial Park, Scunthorpe, South Humberside DN15 8QP.

Typically such infra red sensors have a horizontal field of view of about 160°. In this case it is preferred that two such sensors are incorporated in each intruder detector with their fields of view overlapping to some degree so that the detection range of the intruder detector extends over an angle greater than 180° and preferably over an angle greater than 270°.

Preferably the sensors are positioned with their principal detection axes at an obtuse angle to each other, and more preferably at an angle of substantially 120°.

Preferably the outer limit of the field of view of each sensor extends above the horizontal plane at a first acute angle, and below the horizontal plane at a second acute angle greater than the first acute angle.

Preferably the first acute angle lies in the range 5° to 10° and the second acute angle lies in the range 20° to 25°.

Preferably the intruder detector also includes a movement and tilt sensor and the radio transmitter is responsive to the output of the movement and tilt sensor so that the transmitter transmits a signal in response to the detection of movement or tilt of the intruder detector. Preferably the radio transmitter transmits a different alarm indication in response to the movement and tilt sensor of that from the infra red sensor to enable not only the identity of the detector to be indicated but also the condition that that detector is sensing to be indicated. Preferably the intruder detector also includes a sensor to sense when the charge condition of the battery is low and, under these circumstances, to trigger the radio transmitter to emit a further alarm indication again identifying the identity of the detector and also identifying its low battery state.

Preferably the intruder detector also includes an infra red, ultrasonic, or radio receiver which is responsive to infra red, ultrasonic or radio transmissions to activate a transmitter enable/disenable circuit. In this way, the intruder detectors can be turned ON and OFF by a transmitter located remotely outside the area to be protected. Preferably the receiver only responds to an individually coded signal which enables the detectors, when more than one is being used, to be activated and deactivated individually. Preferably the transmitter is a hand held device and, in this case, such a transmitter can be used by authorised personnel to deactivate one of the intruder detectors in the ring surrounding a protected area to enable the authorised personnel to enter the protected area without raising an alarm.

Typically the output of the, or each, intruder detector is monitored by a central station including a radio receiver to receive the transmissions from the or each intruder detector. Each intruder detector may also include its own local alarm indication by means of a local siren or flashing beacon, for example.

A particular example in accordance with this invention will now be described with reference to the accompanying drawings in which:-

Figure 1 is a block diagram of part of the intruder detector;

Figure 2 is a format diagram of the output of the detector;

Figure 3 illustrates how two devices in accordance with the invention can be used to provide a protection zone around a small aircraft;

Figure 4 shows how a number of devices in accordance with this invention can be used to provide a protection zone around a large aircraft;

Figure 5 gives plan and projected side views of disposition of sensors in the detector head; and

Figure 6 shows the vertical detection angle of sensors with the "ground" as the horizontal reference.

The intruder detector comprises a lead acid battery, and solar powered battery charger (not shown) which provide a power supply for the detector. The detector also comprises an activating circuit responsive to infra red, radio or ultrasonic control signals which are detected by appropriate sensors (also not shown). An output from an infra red sensor is connected to an infra red activator switch input 1, and output from a radio sensor is connected to a radio controlled switch input 2 and an output from an ultrasonic sensor is connected to an ultrasonically controlled switching input 3. The outputs from these three switching inputs are connected to a switching input signal processor 4 which provides an output to a signal decoder 5 which in turn outputs a signal to a timer 6 which, on timing out, feeds a signal to a switching logic control circuit 7 and then to a power controller 8 which controls the application of power as will be described subsequently.

The detector comprises two infra red detectors 9 and 10 such as the FRIM-188 motion detection sensors referred to previously. These sensors are connected to the battery via the power controller circuit 8. The outputs of these detectors are fed to an infra red signal processor 11 and outputs of this are fed to a timer 12 and thence to a press to talk logic circuit 13. The intruder detector also comprises a tilt switch 14 which outputs a signal to a tilt switch signal processor 15. The intruder detector also comprises a battery charge level sensor 16 which is connected to a signal processing circuit 17. An infra red status circuit 18 receives an output from the infra red signal processor 11, a tilt

status circuit 19 receives an output from the signal processor circuit 15 and a battery status circuit 20 receives an output from the signal processing circuit 17. The outputs of these status circuits are fed via a multiplexer 21 to an encoder 22 and from there to a transmitter 23, which, under the control of the press to talk circuit 13, transmits signals via an aerial 24. The transmitter 23 is also connected to the battery via the power controller 8.

The two sensors 9,10 fitted into the detector head 24 are set back approximately 13mm from the periphery of the head enclosure. Both are located in a common horizontal plane with the centre of their respective detection angles 120° apart. The vertical angle a_1,a_2 of detectors is 7½° above the horizontal plane and 22½° below the horizontal plane. Such a depressed detection angle overcomes possible detection anomalies when the system is operating in low illumination angle situations e.g. sunrise, sunset. The reduced surveillance angle in the vertical mode results in the ground level incidence angle being at a point G, 2.5 metres from the base of the detector mounting case and attaining a height of 2.3 metres at H, 10 metres from the base. The principal detection axis extends at an angle a_3 of 10° to point D at 6m from the detector.

A secondary i.r. filter 25,26 is fitted over each viewing window in the periphery of the head corresponding to the viewing position and size determined by the detection angle of the sensors. The filter is of the order of 220 microns thick and is 70 to 75% transmission efficient. Functionally the filters serve as diffuser elements for use primarily in hot desert regions where constant fluctuation of the air temperature with respect to the sand, or rock formation, particularly at certain

times of day and night could lead to erroneous signals being generated.

The intruder detector operates in the following manner irrespective of its disposition or location. The system is activated by the transmission of a coded infra red, radio or ultrasonic signal compatible with and recognisable to the particular detector. On receipt of this signal, and after it has been recognised by the signal processor 4, it is decoded in the decoder 5 and converted into a time input signal 6. The time signal sets the switch and logic circuit 7 to a state which unlocks the power controller 8 to enable it to supply a DC output to the detectors 9 and 10 and alarm transmission circuits such as the transmitter 23. Immediately the DC supply is switched ON the detection network and alarm transmission circuits are active.

Incident infra red radiation is focused on the infra red sensors 9 and 10 by wide angle lenses. If the pattern of radiation is constant no output is obtained from the sensors 9 and 10. However if a body within the spectral range of the sensors i.e. with an infra red output having a wavelength of between 4 and 20 microns, moves into or out of the detection range of either of the sensors 9 or 10 the sensor generates a transient voltage. Similarly, a transient voltage is generated if the radiation pattern of a static body in the zone is raised or reduced above or below a minimum detection level. No calibration of the sensor is necessary an and output signal is generated only in response to different levels of infra red radiation on separate parts of the sensor element.

Presuming the tilt switch 14 is correctly set and the battery level sensor 16 senses an adequately charged battery, no signals are input through the appropriate signal processors 15 or 17 via the tilt 19 and battery

status 20 inputs to the multiplexer 21. Thus the transmitter 23 is locked off by the disabled output from the press-to-talk logic circuit 13.

In situations where the tilt switch 14 is dislodged or the battery level sensor 16 indicates that the voltage level is low then an appropriate warning signal is transmitted by enabling the press-to-talk logic output 13.

If a transient voltage is generated from either sensor 9 or 10 by a moving object or if a body is hotter or colder than a set reference level, this is established after processing by the signal processor 11 and an output is routed to the timer 12 and the infra red status circuit 18. The timer 12 enables the press-to-talk logic 13 and sets its output to the "talk" level. The radio 23 transmits two signal bursts at approximately 10 second intervals over a fixed alarm period of 15 seconds prior to the automatic resetting of both it and the detector timer network. The radio transmitter 23 outputs the unique coded signal identifying the particular detector and identifying, as a result of the encoder 22, the nature of the alarm signal which is being given, i.e. whether it results from the presence of an intruder, the activation of the tilt switch 14 or the activation of the battery sensor 16.

Figure 2 illustrates the format of the coded signal which is transmitted by the transmitter 23. Firstly there is an initial 30 milli-second delay period P_1 followed by a second period P_2 during which a tone, unique to the individual detector is transmitted. This first tone period lasts typically between 20 and 100 milli-seconds. There is then a second delay period P_3 of length of about twice as long as the first tone so having a time period of between 40 and 200 milli-seconds. Fourthly there is an alarm period P_4 during which a tone

dependent upon the nature of the alarm being raised is transmitted typically for a period twice as long as the initial tone. This is again, typically of length between 40 and 200 milli-seconds. The total duration D is typically 15 seconds.

The detection system can also be switched OFF either temporarily or permanently, by using the infra red radio or ultrasonic signal generator to deactivate the power controller 8.

All of the components of the intruder detector in accordance with this invention are housed within a simple housing such as a cylindrical housing of height of approximately 1 metre terminating in a spike to enable the devices to be located by merely being pushed into the ground. To facilitate camouflaging the device the various components may, if required, be housed in more than one separate package.

Figure 3 illustrates how two detectors in accordance with this invention can be used to define a protected area around a small plane such as a Harrier jump jet. As shown in Figure 3 one sensor 30 is placed in front of the aircraft whilst the other sensor 31 is placed behind the aircraft. The detection zones for each of the sensors 9 and 10 in each of the detectors 30 and 31 are illustrated in Figure 3. As shown the fields of view of both sensors 9 and 10 overlap slightly to give a continuous field of view for the entire sensor which extends around an angle of about 300° and the fields of both detectors 30 and 31 also overlap.

With a larger aircraft such as a Boeing 747 a greater number of detectors are required and Figure 4 illustrates how 10 intruder detectors in accordance with this invention can be arranged around such an aircraft to define the protected zone. The detectors 40 to 49 are placed around the aircraft pointing generally outwards

but with their fields or view overlapping as shown in Figure 4.

CLAIMS

1. A passive infra red intruder detector including a sensor sensitive to changes in the pattern of infra red radiation within its detection range and in a wavelength range from 4 to 20 microns, a radio transmitter which transmits a signal including a detector identification and an alarm indication and which is triggered upon detection of a change in the pattern of infra red radiation by the sensor, a battery providing a power supply for the sensor and transmitter, and a solar cell powered battery charging circuit for recharging the battery.

2. A detector according to claim 1, in which the infra red sensor includes a pyroelectric transducer having a built-in preamplifier.

3. A detector according to claim 1 or 2, including two infra red sensors positioned with fields of view overlapping and providing a combined field of view subtending an angle at the detector greater than 180°.

4. A detector according to claim 3, in which the field of view subtends an angle at the detector greater than 270°.

5. A detector according to claim 3 or 4, in which the sensors are positioned with their principal detection axes at an obtuse angle to each other.

6. A detector according to claim 5, in which the outer limit of the field of view of each sensor extends above the horizontal plane at a first acute angle, and below the horizontal plane at a second acute angle greater than the first acute angle.

7. A detector according to claim 6, in which the first acute angle lies in the range 5° to 10° and the second acute angle lies in the range 20° to 25°.

8. A detector according to any one of claims 3 to 7, in which the sensors are mounted on a detector head in a

common horizontal plane and set back towards the centre of the head, the head further comprising a secondary infra red filter for each sensor formed in the periphery of the head and subtending substantially the same angle at the respective sensor as the field of view of the sensor.

9. A detector according to any one of the preceding claims, further including a movement and tilt sensor, and in which the radio transmitter is responsive to the output of the movement and tilt sensor to transmit an alarm signal.

10. A detector according to claim 9, in which the radio transmitter transmits different respective alarm indications in response to detection of movement or tilt and detection of a change in the pattern of infra red radiation.

11. A detector according to any one of the preceding claims, further including a sensor arranged to sense when the charged condition of the battery is low and to trigger the radio transmitter to emit an alarm indication identifying a detector and the low battery state.

12. A detector according to any one of the preceding claims, further including a receiver responsive to an infra red, ultrasonic, or radio transmission to enable or disenable the detector.

13. A detector according to claim 12, in which the receiver responds only to an individually coded signal.

14. A detection system comprising a plurality of detectors according to any one of the preceding claims, arranged around a zone to be protected with the detection zones of adjacent detectors overlapping.

15. A detector substantially as described with respect to the accompanying drawings.

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